Method for the correction of video signals

FIELD OF THE INVENTION

5   The invention relates to a method for the correction of
video signals.

Line-array optoelectronic transducers such as CCD line
sensors are used for scanning films and other pictures.
10   Pixels from the line-array optoelectronic transducer
are in this case frequently read over two or more
channels. By way of example, the pixels from the
optoelectronic transducer can be read over four
channels, with one line of the optoelectronic
15   transducer being read in different directions starting
from a central start point, and with successive pixels
being read to different channels, so that a total of
four channels exist.

20   These channels, which essentially comprise the pixels,
a register and an amplifier in each case, are subject
to manufacturing tolerances which affect the linearity,
the gain and any offset (black value). This means that
the value of every second pixel may be different from
25   the values of the adjacent pixels even if the picture
content has no changes.

Errors can occur in particular as a result of the
reading of successive pixels in two different channels
30   in each case, and from the start point of the
optoelectronic transducer, from which the sensor, which
is in the form of a row, is read to the right and to
the left.

35   SUMMARY OF THE INVENTION

During the scanning of films and other pictures, these
errors may become apparent as fine strips running
vertically.

The present invention is based on the problem of
providing a method for the correction of video signals
which reduces or eliminates errors of this type.

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A correction of video signals exhibiting errors of this
type is achieved by the method according to the
invention by means of the features of Claim 1.

10 The errors mentioned in the introduction can be
automatically corrected by the method according to the
invention, so that such stripe-like errors are no
longer discernible. A preferred field of application at
the present time is the processing of video signals
15 read from linear-array sensors via two channels.
However, other applications are also possible, for
example those with more than two channels. Following
analogue/digital conversion, the video signals are in
the form of digital picture signals. In the present
20 connection, the term "value" is tantamount to "sample".

A first step is based on determining an error caused by
the reading of successive pixels in two different
channels in each case. In this case, provision is made
25 for estimated values for the pixel values of a second
channel to be formed by means of interpolation from the
pixel values transmitted via a first channel, and for
correction values for the pixel values of the second
channel to be derived from differences between the
30 estimated values and the actual pixel values of the
second channel.

The method according to the invention preferably
provides for the correction values to be formed only
35 from differences which are less than a predetermined
value. Provision is in this case made for an associated
pixel value to be defined relating to the difference. A
characteristic is determined from this over the entire
profile of the pixel values, from which an addition

value and a multiplication factor are derived, as a
function of the pixel values, depending on the level.
The profile of the pixel values may be linear or may be
in discrete form, for example into 100 zones. This

5   prevents structures that are actually present in the
picture from influencing the calculation of the
correction values.

In principle, with the method according to the

10   invention, it is possible to correct the signals of the
other channel and thus to match them to the signals of
the first channel. More precise correction results,
however, with the aid of a development of the method
according to the invention in that furthermore, further

15   estimated values are formed by interpolation of pixel
values transmitted by means of the second channel, in
that further differences are formed from the further
estimated values and the pixel values of the first
channel, in that an average value is in each case

20   formed from the differences and the further
differences, and in that the correction value is
derived from the average values.

This development may preferably be configured in such a

25   way that the differences and the further differences
are in each case subtracted from one another, and in
that the respective average value of the differences is
only used for correction if the value produced by
subtraction of the difference and the further

30   difference is less than a further predetermined value.
As a result, estimated values are also precluded from
use for forming the correction values if the two
estimates lead to significantly different results,
which may possibly be the case with specific picture

35   structures.

A correction of the video signals whilst taking account
of amplitude-dependent errors is preferably possible in
that the differences and the further differences, for

the purpose of forming the correction values, are
averaged separately according to the magnitude of the
pixel values, in that the correction values are written
to a memory, and in that the correction values are read
5   from the memory depending on the respective magnitude
of the pixel values and are added to the video signals
of the first and/or the other channel.

In this development of the method according to the
10   invention, it may be provided that the averaging is in
each case effected separately according to magnitude
ranges of the pixel values, and in that correction
values are obtained for the individual amplitude values
by interpolation and low-pass filtering. During the
15   interpolation and low-pass filtering it is possible to
employ functions which take account of the differences
that occur between the two channels, and prevent
differences that do not occur, such as step junction
changes, for example, in the transfer characteristics
20   during the formation of the correction values.

In one preferred procedure, the frequency of the time
profile of the pixel values is determined, as is
referred to for short in the following text as the
25   "signal frequency". When calculating the correction
values, the only pixel values which are taken into
account are those which lead to a signal frequency
which is below a specific cut-off frequency since,
otherwise, errors occur which lead to unsuitable
30   correction values. This development goes beyond the
already mentioned investigation of the magnitude of the
pixel values, since the calculation of the correction
values also rejects pixel values which remain below the
stated limit values. The cut-off frequency may depend
35   on the limit values. In one simple case, the cut-off
frequency may be chosen to satisfy the Nyquist
criterion.

It is also possible to provide for a weighting factor
to be determined from how well the test criteria are
complied with, with this weighting factor being used to
determine the extent to which a pixel value is included
5   in the subsequent calculation of the correction values.
The weighting factor represents a measure of the
usefulness of a pixel value.

BRIEF DESCRIPTION OF THE DRAWINGS
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An exemplary embodiment of the invention is illustrated
in the drawing on the basis of several figures and
explained in more detail in the description below. In
the figures,
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Figure 1   schematically shows an optoelectronic linear-
             array sensor,

Figure 2   shows a diagram with values of pixels of the
20   two channels, and

Figure 3   shows a block diagram of an arrangement
             according to the invention.

25   DETAILED DESCRIPTION OF AN EXEMPLARY EMBODIMENT

Although the exemplary embodiment and parts thereof are
illustrated as a block diagram, this does not mean that
the arrangement according to the invention is
30   restricted to a realization with the aid of individual
circuits corresponding to the blocks. Rather, the
arrangement according to the invention can be realized
particularly advantageously with the aid of large scale
integrated circuits. In this case, it is possible to
35   use digital signal processors which, given suitable
programming, carry out the processing step illustrated
in the block diagrams.

Figure 1 shows, in highly schematic form, a linear
optoelectronic transducer of the kind used in film
scanners, in which a line of optical sensors is
composed of two segments 2, 3. The charges respectively
5   corresponding to the brightness of a pixel are
transferred in parallel from the individual picture
cells of the sensor into registers 4, 5, 6, 7 and are
read serially from the latter. In this case, one of the
registers 4 and 5, and 6 and 7, respectively, is used
10   pixel by pixel in multiplex.

At the outputs of the registers 4, 5, 6, 7 there are
analogue amplifiers 8, 9, 10, 11, from the outputs of
which the signals are fed to analogue/digital
15   converters 13, 14 (Figure 3). The boundary between
semgnets 2, 3 is shown by a separating line 12.

The transfer characteristics of the channels A, B, C, D
differ from one another due to manufacturing
20   tolerances. These differences may concern
nonlinearities, different gain factors or offsets of
the components used, in particular of the picture cells
of the sensor.

25   In Figures 2a and 2b, a plurality of values of the
video signals from the two channels are in each case
plotted against time t or the location x. As a result
of the linear scanning, a particular time corresponds
to a particular location. Values from the channel A are
30   identified by black dots and designated by A1 to A6.
Values from the channel B are symbolized by circles and
bear the designations B1 to B5. As a result of the
pixel-sequential read-out from the optoelectronic
transducer, the channels are in each case offset by one
35   pixel or one pixel duration.

In the case of the process illustrated in Figure 2a, a
suitable filter is used to obtain a respective
estimated value by interpolation of adjacent values A1

and A6, which is identified by a cross. Differences
result between the estimated values and the actual
values B1 to B5 of the channel B, the further
processing of which differences will be explained later
5   in connection with Figure 3.

Figure 2b shows the interpolation between the values B1
to B5 of the channel B and the difference formation
between the estimated values thus produced and the
10   values A2 to A5 of the channel A.

The initially analogue signals of the channels A and B
are fed to the arrangement according to Figure 3. The
signals are respectively passed via an analogue/digital
15   converter 13, 14 to filters 21, 22, which each carry
out the interpolation illustrated in Figures 2a and 2b.
The subsequent formation of the differences takes place
in subtractors 23, 24. The difference between the
differences is formed in a further subtractor 27. This
20   is because if the differences deviate from one another
to an excessively great extent, then they are not used
to form the correction values. To that end, a
comparator 28 is provided, which generates an enable
signal Q2 only if the difference is less than a
25   predetermined value K2.

The differences themselves are also checked in a
similar manner, namely in comparators 25, 26, which
generate an enable signal Q1 only when the respective
30   difference is less than a predetermined value K1.

Signal levels which are associated with the difference
are defined as a necessary criterion and are used to
determine a characteristic over the entire amplitude
35   profile, which is level-dependent and provides an
addition value and a multiplication factor. The
amplitude profile may be linear or may be in discrete
form, for example being subdivided into 100 zones.

A further filter 45 is provided in order to assess the
signal frequency, and its input side is connected
firstly to the output of the analogue converter 13, and
secondly to the analogue/digital converter 14 for the
5   channel B. The output side of the filter 29 is
connected to inputs of the accumulators 30, 31, in
which the determined differences are accumulated
separately on the basis of amplitude zones when the
enable signals Q1, Q2 are present. A high-pass filter
10   component which is produced from the filter 29 forms
one criterion for the assessment of the measurement
results which are stored in the accumulators 30, 31. If
the signal frequency is too high and its signal
amplitude is too great, then no useful statement can be
15   made about the amplitude profile, so that the
measurement results are rejected. However, if the
frequency f is below a cut-off frequency N/4 or F, and
the amplitude of the signal is below a limit amplitude,
then a factor for the usefulness of this measurement
20   value is determined and is used in a subsequent
averaging process to determine the extent to which the
individual measurement result is included in the
correction calculation. N represents the frequency at
which the line-array sensor is read, so that N/4
25   represents the so-called Nyquist frequency. Depending
on the evaluation parameters, in particular on the
limit values K1 and K2, a lower cut-off frequency F may
be provided for the filter 45. This option, which is
not necessarily available, is shown by a dashed line in
30   the filter 45 in Figure 3. The signal frequency is
investigated in the filter 45 for two reasons. Firstly,
the Nyquist criterion must be satisfied, in order to
avoid undersampling in one channel. Secondly, it is
necessary to ensure that pixel values originate only
35   from the value range to be evaluated, and are not
distributed around it. If picture contents whose
contents vary too quickly are evaluated, then this can
lead to difficulties.

The values themselves - that is to say the output
signals of the analogue/digital converters 13, 14 - and
also the differences are fed to accumulators 30, 31,
which accumulate the differences separately according
5   to amplitude ranges if the enable signals Q1, Q2 are
present. A respective sample and reset circuit 32, 33
ensures that a sufficiently large number of values
suitable for forming correction signals are accepted
without the accumulators 30, 31 overflowing. These
10   values are divided, at 34, 35, by the number of values
respectively accumulated for an amplitude range,
thereby producing average values. Correction curves are
determined therefrom by interpolation and are smoothed
in filters 36, 37.
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The smoothed correction curves produced by the filters
36, 37 contain, for each digital sample, a correction
value which is in each case written to a table, which
tables are stored in memories 38, 39. Suitable memories
20   38, 39 are commercially available digital memory
modules. Depending on the digital values of the video
signals of the two channels the correction values are
in each case read from the memories 38, 39 and fed via
a respective adder 40, 41 to the video signals. The
25   corrected video signals can then be taken from the
outputs 42, 43.

The determined correction values are recorded over a
lengthy time period, without being used immediately.
30   When, and only when, a result which is stable within
predetermined limits is obtained, the correction
process is carried out in steps, in order to avoid
rapid picture changes. This allows use to be made of
the capability to monitor the effects of the correction
35   process, and to determine whether the correction has
the desired characteristics.

Although the description has always referred to CCD
sensors, the invention may, however, also be used

irrespective of the nature of the sensor. For example, the invention can also be used for CMOS sensors.